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(54) Sealing within pipes

(57) A pipe is sealed by forming therein a resiliently deformable seal. In one application a, new service pipe 10 is passed inside an existing pipe 12. A branch pipe 14 is broken away, and an injection gun 23 is placed sealingly on the opening 18 so formed, and used to inject a sealant material to form a resiliently deformable annular seal 24 upstream of the branch 14, which can then be connected to the new pipe 10.

Preferably the sealant material expands to a closed cell polyurethane foam, with a gelation time of 2-3 minutes. The gun may have a mixing chamber closed by a rupturable member which ruptures to allow injection when the material has expanded to a degree indicative of readiness.

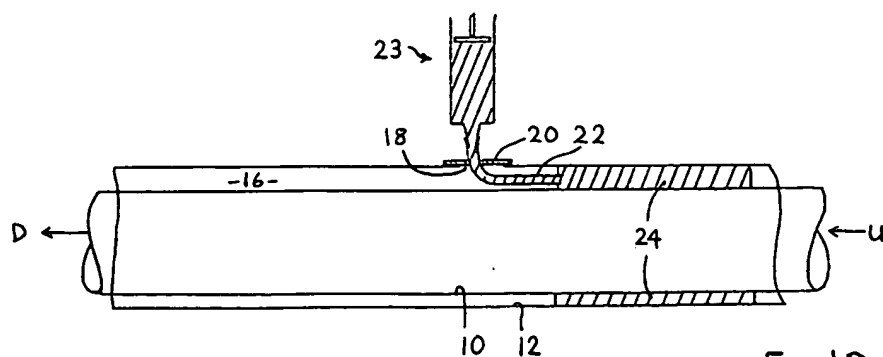


Fig 1B

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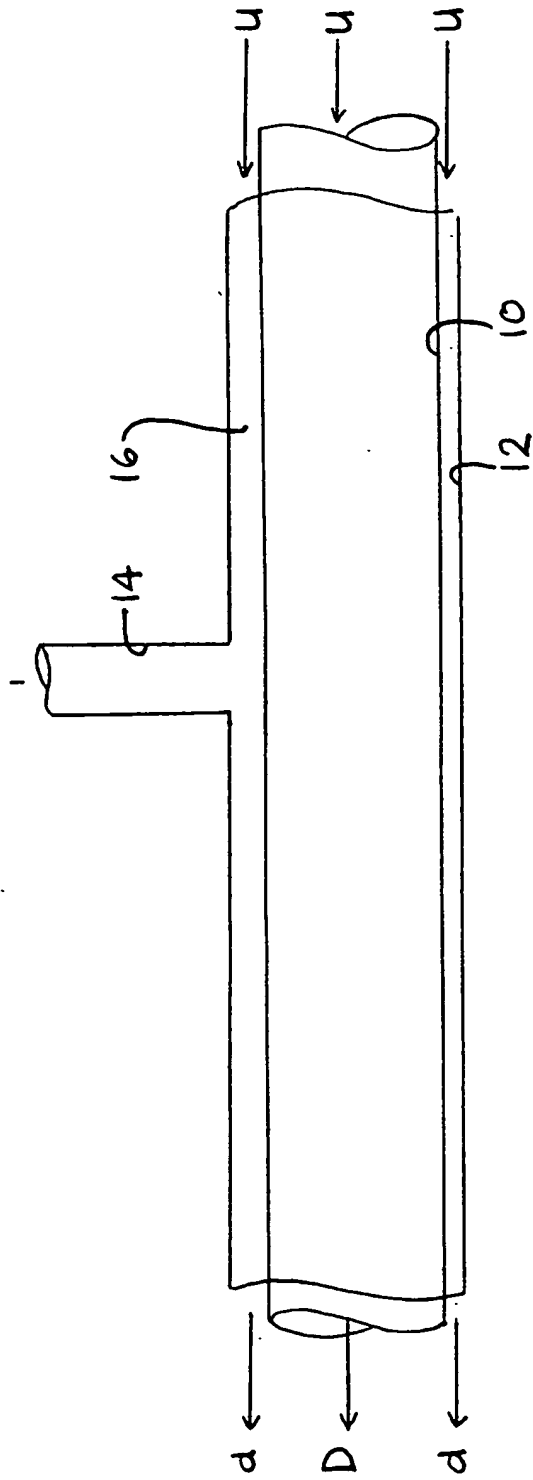


Fig 1A

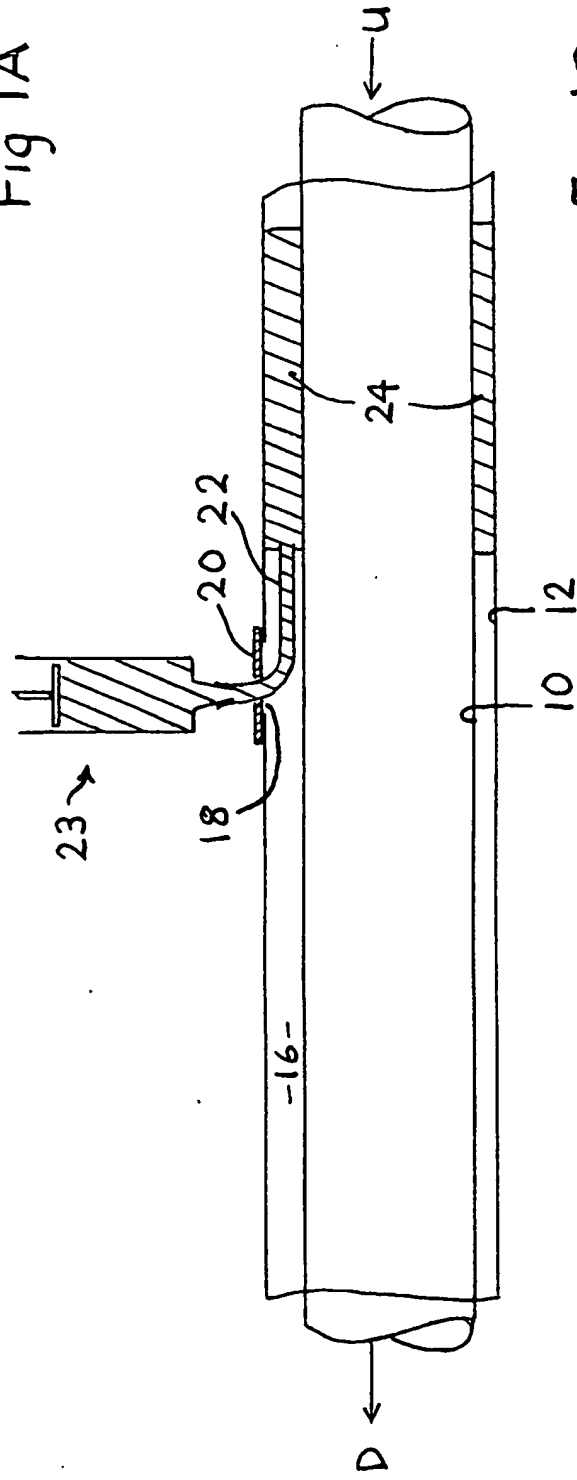
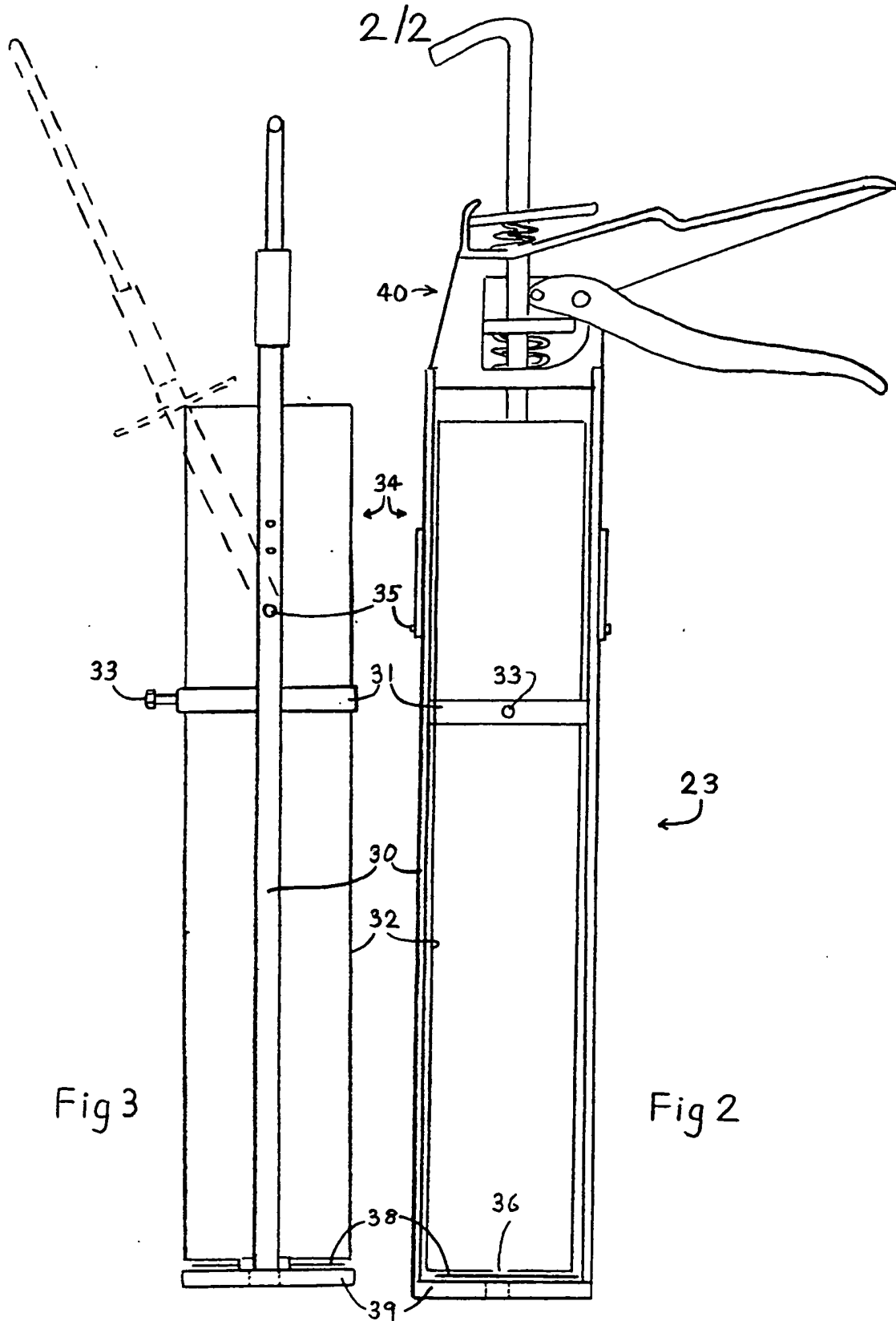


Fig 1B

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SPECIFICATION

Sealing within pipes

- 5 The present invention relates to a method of sealing within pipes, to a method of installing replacement service pipes using such a sealing method, and to apparatus and sealant material for use in such methods. 5

To replace a gas main, for example, the traditional method has involved excavation of a trench for the whole length of the main, which is then removed. A more recent technique reduces the amount of digging; A small trench is dug at the end of a section of main to be replaced. A new main section of smaller diameter is 10 passed into the old section, and connected up so that gas can pass along the new section as well as in the annular channel between the old and new sections. The annular channel provides a gas supply to the various branch service pipes leading to users situated along the section of the main. The next task is to connect these service pipes to the new main section. Starting with the pipe furthest downstream, a short trench is dug adjacent its connection to the main. The pipe is disconnected, thus exposing a hole in the old main. A sealant 15 composition is passed into the annular space upstream of the hole so as to form an annular seal. The old main in the region of the branch pipe is then broken away, and the pipe is connected to the new main. Similar procedures are applied to successive pipes along the length of the new section. The bulk of the old main remains in the ground, but no longer in use.

It will be appreciated that this technique has great advantages. The amount of excavation - which may be 20 by far the major cost of pipe replacement - is greatly reduced. This reduces cost, and general inconvenience to road users and others. Furthermore, the amount of time for which an individual consumer's gas supply is cut off is also much reduced. There will be a short time while the consumer's branch pipe is being reconnected, but during the rest of the process, the consumer has a normal gas supply, since the old main continues to provide gas (via the annular channel) until the new main is connected. The process of 25 reconnecting one branch pipe does not affect the others.

The efficient performance of this method depends on the ability to provide an annular seal between the old and new mains. The sealant must be capable of forming a seal while subject to the flow of gas under pressure, and the seal once formed has to hold back the gas pressure until the next seal is installed upstream. When the old main is being broken up adjacent the seal, which is commonly done with sledge 30 hammers, there is considerable risk of damage to the seal due to vibrations and relative movements of the old and new mains.

According to the present invention in one aspect, there is provided a method of providing a seal within a pipe by passing into said pipe a sealant material which sets to form a resiliently deformable seal. In another 35 aspect the invention provides a method of replacing a service pipe comprising providing a first service pipe section within a second service pipe section so that there is a generally annular space between them; and providing a resiliently deformable annular seal in said space by a method according to the first aspect.

Preferably the sealant material comprises an expansion foam composition which cures to form a closed-cell foam seal. Suitable compositions are polyurethane-based, with expansion ratios preferably in the range 3:1 to 4.5:1. A cure rate such that the gelation time is about 2 to 3 minutes is preferred. 40 The sealant composition may be allowed to expand in an expansion chamber which is communicable with the annular space, the communication being initially prevented by barrier means (e.g. a rupturable member) arranged to allow communication (e.g. by rupturing) when expansion has occurred to a predetermined degree. Of course, this technique of using an expansion chamber with a rupturable member is of wide utility, not restricted to annular seals for service pipes or to resilient seals. It means that a composition will always 45 be dispensed when it has attained the correct degree of expansion. There is no need to measure the ambient temperature and then estimate the delay time.

The method as a whole is particularly applicable to gas mains, but may of course be applied to other pipework, e.g. service pipes for water or sewage.

In further aspects the invention provides a sealant material for use in the method, a seal formed thereby, 50 and a service pipe assembly installed by the method. It also provides an injection gun assembly.

A preferred embodiment of the invention will now be described with reference to the accompanying drawings in which:

Figure 1A and 1B are schematic sectional views showing the replacement of a section of a gas main by means of a method embodying the invention;

55 *Figure 2* is a side elevation on a larger scale of an injection gun assembly; and 55

Figure 3 is a view similar to *Figure 2* but in front elevation and with part of the gun removed.

Figure 1A shows a stage in a method embodying the invention when a new gas main section 10 has been installed within an old section 12, as described above with reference to the prior art. A hole has been dug to give access at the region where a branch pipe 14 branches off to a consumer. Gas pressure is communicated 60 to both of the mains 10, 12 from the upstream end (arrows U). Gas passes uninterruptedly through the new main 10, as indicated by downstream arrow D. Gas passes along the annular conduit 16 between the old and new mains, some emerging downstream (arrows d), and some being drawn off into the pipe 14 (arrow S) if required.

Figure 1B shows the next stage in the process. The pipe 14 has been disconnected from the old main 12, 65 leaving a hole 18. A sealing material 20 with a central aperture, is placed over it, and a tube 22 is pushed 65

through the aperture, so that the tube extends upstream of the hole 18. An injection gun 23 is then used to inject liquid sealant material through the tube 22 into the annular conduit 16 where it cures to form an annular seal 24.

A preferred injection gun is shown in greater detail in Figures 2 and 3. It has a frame 30 for holding a disposable cartridge 32 by means of a support ring 31 with a locking screw 33. The head section 34 is articulated (with a pivot 35) to the frame 30 so that it can be swung clear (as shown in broken lines in Figure 3) to allow insertion and filling of a cartridge 32.

The cartridge 32 has the form of a cylindrical cup with a central aperture 36 in its base for communicating with the nozzle of the gun. In use, before the cartridge 32 is placed in the frame 30, a rupturable impermeable disc 38, suitably of greaseproof paper, is placed on the base 39 of the frame. This stops the sealant from escaping and, more importantly, prevents the pressure in the pipe 10 from forcing gas up through the gun.

The sealant is mixed just before use, and poured into the cartridge 32 in the gun. The head section 34 is swung into position, and a conventional trigger arrangement 40 is used to insert a piston just into the top of the cartridge so that the sealant is in a chamber closed at top and bottom by the piston and the disc 38. There is now a delay period, depending on the ambient temperature, while the sealant compound generates its own exotherm and commences to expand. Being contained within the cartridge, this expansion eventually causes the paper disc to rupture. The sealant is then pumped steadily into the annular space 24. This mechanism allows the sealant to be extruded at the optimum time notwithstanding the ambient temperature at the time of application. The sealant in the conduit 24 is allowed to complete its expansion and reach an initial cure over a period of (typically) a few minutes. Of course, the actual time depends on the details of the formulation. Then the old pipe 10 can be broken up adjacent the service pipe 14, the seal 24 being strong and resilient enough to withstand the likely shocks.

Of course, the utility of the injection gun assembly is not restricted to methods embodying the invention. After use, the cartridge may be discarded.

The preferred sealant composition is basically a polyurethane foam-forming formulation. Of course, polyurethane foams are well known for a wide variety of applications, but formulations embodying the present invention must have special properties. In development trials we found that the important factors are that the foam produced should be flexible and closed-cell, and that a suitable volume of expansion and rate of cure should be used. The results of some tests are summarised below.

Tests were carried out with compositions having an expansion ratio of 2.5 to 1, and having various cure rates. It was found that insufficient final cured material was produced to fill the annular space between two typical sized pipe combinations.

The variation of the cure rate showed that, unless a rapid gelation was used the liquid injected into the annular space would simply flow too far along the outer pipe, preventing expansion of the system having any significant effect. This is the case whatever the expansion ratio. At present we prefer systems having a gelation time of 2 - 3 minutes at 20°C which can be used consistently successfully at all expected ambient temperatures with the aid of the rupturable disc as an indicator of readiness.

A system was then tried with a 3:1 expansion ratio and a rapid cure rate. This was found to be only intermittently successful in adequately filling the annular space.

A further system was tried with an expansion ratio of 5:1 together with a rapid cure rate. Although this adequately filled the annular space the final cured seal showed signs of volume instability.

A system with an expansion ratio of 4:1 and a rapid cure rate was investigated. This proved to be consistently successful and the final cured product was acceptably stable.

We believe that the preferred range of expansion ratios is from 3:1 to 4.5:1, and most preferably about 4:1.

A typical formulation for the sealant is a two part composition comprising:

Part A (Liquid Base)

50	Polyether or Polyester diol or triol Molecular Weight 1500 - 6500	68% - 98%	50
	Optional Short Chain diol or triol Molecular Weight 60 - 400	0% - 30%	
55	Catalyst Tertiary Amine or Organo Metallic Catalyst	approx. 1%	55
	Surfactant e.g. silicone oil	approx. 1%	
60	Water	up to 3%	60

Part B

Diphenyl methane 4 - 4' diisocyanate (MDI) in the form of a crude mixture of MDI, Isomers and Polymers or alternatively a Prepolymer based on MDI, containing residual unreacted MDI.

65

Part A may be further modified by adding suitable inorganic fillers such as slate, flour, silica, whiting, china clay, talc, gypsum, etc.

The mix proportions of Part A and Part B are calculated to give a mole ratio OH : NCO of 0.5 : 1.0 – 1.5 : 1.0.

The final form is flexible, resilient and of closed cell structure.

5 The measured hardness of the foam surface is within the range 5 - 50 degrees shore A.

5

CLAIMS

1. A method of providing a seal within a pipe by passing into said pipe a sealant material which sets to form a resiliently deformable seal. 10
2. A method according to claim 1 wherein the sealant material comprises an expansion foam composition which cures to form a closed-cell foam seal.
3. A method according to claim 2 wherein said composition has an expansion ratio generally in the range 3:1 to 4.5:1 and cures to a polyurethane-based foam.
- 15 4. A method according to any preceding claim wherein the sealant material has a gelation time generally in the range 2 to 3 minutes. 15
5. A method according to any preceding claim wherein the sealant composition expands, said expansion initially occurring, in an expansion chamber which is communicable with the pipe interior, the communication being initially prevented by barrier means arranged to allow communication when expansion has occurred to a predetermined degree. 20
6. A method according to claim 5 wherein the barrier means comprise a rupturable member which ruptures to allow communication.
7. A method according to claim 5 or 6 wherein the barrier means is arranged to allow communication when the pressure generated by the expansion of the composition indicates that it is capable of forming a said seal. 25
8. A method according to any preceding claim when applied to a gas main.
9. A method of replacing a service pipe comprising providing a first service pipe section within a second service pipe section so that there is a generally annular space between them; and providing a resiliently deformable annular seal in said space by a method according to any preceding claim.
- 30 10. A method according to claim 9 wherein said second pipe section has a branch pipe and this is disconnected to provide an aperture into said pipe section; whereafter means for passing sealant material into the annular space are applied so as to seal the aperture; and said sealant material is passed in through said aperture. 30
11. A method of replacing a service pipe substantially as herein described with reference to and/or as illustrated in the accompanying drawings. 35
12. A replacement service pipe installed by a method according to any of claims 9 to 11.
13. A sealant material for use in a method according to any of claims 1 to 11 which is a foam composition adapted to form a closed-cell foam, and which has an expansion ratio substantially in the range 3:1 to 9:2 and a gelation time substantially in the range 2 to 3 minutes.
- 40 14. A sealant material according to claim 13 which cures to a foam of which the hardness of the surface is substantially in the range 5-50 degrees Shore A. 40
15. A sealant material according to claim 13 or 14 and substantially as any herein described.
16. Apparatus for use in injecting a sealant material into a pipe, comprising a chamber, an injection conduit leading from the chamber, and pressure-dependent barrier means for preventing passage of material out of the chamber via the conduit until a predetermined pressure is attained in the chamber. 45
17. Apparatus according to claim 16 wherein the barrier means comprise a member arranged to rupture to permit passage through the conduit.
18. Apparatus according to claim 17 wherein the member is a paper membrane.
19. Apparatus according to claim 16, 17 or 18 wherein the chamber is provided by a disposable cartridge.
- 50 20. Apparatus according to claim 19 wherein said cartridge has an exit port and the apparatus further comprises a housing for locating said cartridge with its port in register with the injection conduit, a said barrier means being disposed between them. 50
21. Apparatus for use in injecting a sealant material substantially as described herein with reference to and as illustrated in the accompanying drawings.
- 55 22. A method according to any of claims 1 to 11 wherein said passing in of the sealant material is effected by means of an apparatus according to any of claims 16 to 21. 55